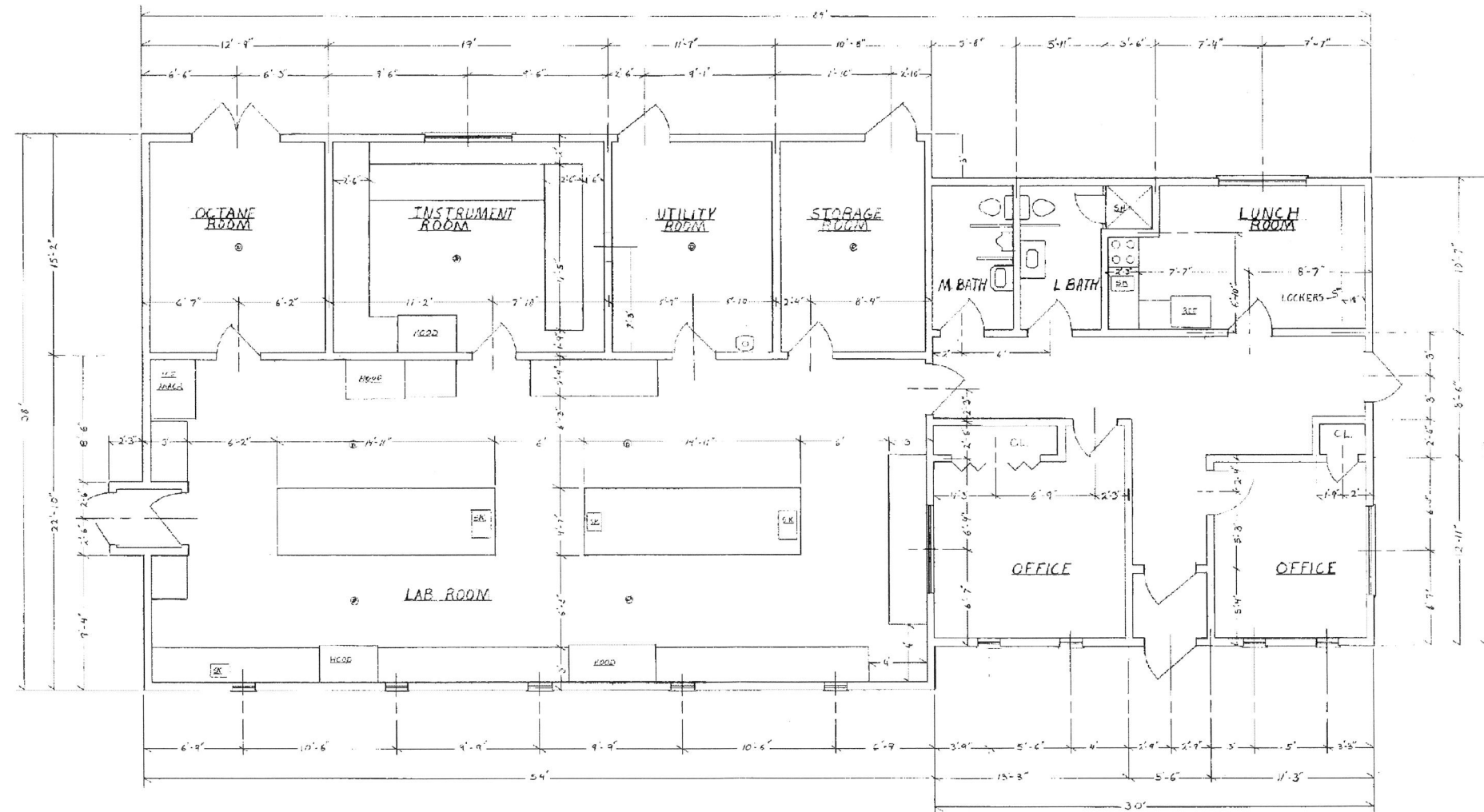


Chemicals in Lab Sump	
Hydrocarbon Reagents	
1,2-dichloroethane-d4	Isopropanol
1,4-dichlorobenzene-d4	Isopropyl benzene
2-Propanol	Methanol
4-bromoflourobenezene	methyl ethyl ketone
5-choloro-tricholoromethyl pyridine	methyl isobutyl ketone
80% iso-oct/20% n heptanes	Mineral Oil
acetone	MTBE
acetonitrile	naphthalene
Benzene	n-butanol
BOD Nutrient buffer	n-butyl benzene
chlorobenzene-d5	n-decane
cyclohexane	n-heptane
cyclopentane	n-nonane
ETBE	neo hexane
ethanol	oil & grease standard
ethylbenzene	pentane
flourobenezene	Petroleum Ether
Heptanes	pH buffer kit
hexadecane	potassium hydroxide
hexane	propylene glycol
hydranal coulomat	silicon bath oil
iso amyl alcohol	silver nitrate
isobutyl alcohol	sulfolane
Iso-octane	synthetic pump oil
Other Reagents	
1,10-phenanthroline-p-toluene sulfonic acid salt	polyvinyl alcohol
12-hydroxystearic acid	potassium bi-iodate
2-chloro-6-(trichloromethyl)pyridine	potassium chloride solution
4,5-dihydroxy-2,7-naphthalenedisulfonic acid, disodium salt	potassium dichromate
4-aminoantipyine	potassium ferricyanide
4-aminoantipyine phosphate	potassium hydrogen phthalate
acetic acid	potassium hydroxide
acetonitrile	potassium iodide
alkali iodine azide solution	potassium nitrate
aminomethylpropanol	potassium nitrite
Ammonium chloride	potassium oxalate
Ammonium hydroxide	potassium permanganate
Aniline	potassium phosphate, dibasic
ascorbic acid	potassium phosphate, monobasic
asino ethylpropanol	potassium pyrosulfate

Chemicals in Lab Sump	
Barium Chloride	potassium sodium tartrate
boric acid	potassium sulfate
Bromine	propionic acid
Buffer solution pH10	SALT FOR DEICING AND WATER SOFTENERS
Buffer solution pH4	silica gel
Buffer solution pH7	silver chloride
cadmium	silver nitrate
calcium chloride	silver sulfate
calmagite	sodium acetate
Carbon Disulfide	sodium azide
CDTA trisodium salt	sodium bicarbonate
chloroform	sodium borate
chromium trioxide	sodium carbonate
citric acid	sodium chloride
Cupric Carbonate, basic	sodium gluconate
Cupric Nitrate	sodium hydrosulfite
dextrose	sodium hydroxide
diethanolamine hydrochloride	sodium iodide
DIETHYLENE GLYCOL MONOMETHYL ETHER (FSII)	sodium metabisulfite
dilute hydrochloric acid	sodium molybdate
Dilute Nitric Acid	sodium phosphate
dilute sulfuric acid	sodium Plumbite
diphenylcarbazone indicator	sodium sulfanilate
EDTA	sodium sulfate
ferrous ammonium sulfate	sodium sulfide
ferrous chloride	sodium sulfite
ferrous sulfate	sodium tartrate
formaldehyde	sodium thiosulfate
gentisic acid	Stadis 450
Glutamic Acid	starch indicator
glycerine	sulfanilic acid
hydrogen peroxide	sulfur
iodine	talc
iodine monochloride	tartaric acid
lithium chloride	trichloro-trifluoro ethane
lithium hydroxide	various mineral salts
lithium nitrate	t-amyl alcohol
magnesium sulfate	tetrahydronaphthalene
Manganese Nitrate	tetramethylbenzenes
mercuric iodide	Toluene
Mercuric Nitrate	Toluene-d8
mercuric sulfate	trichloroethylene (slight possible)

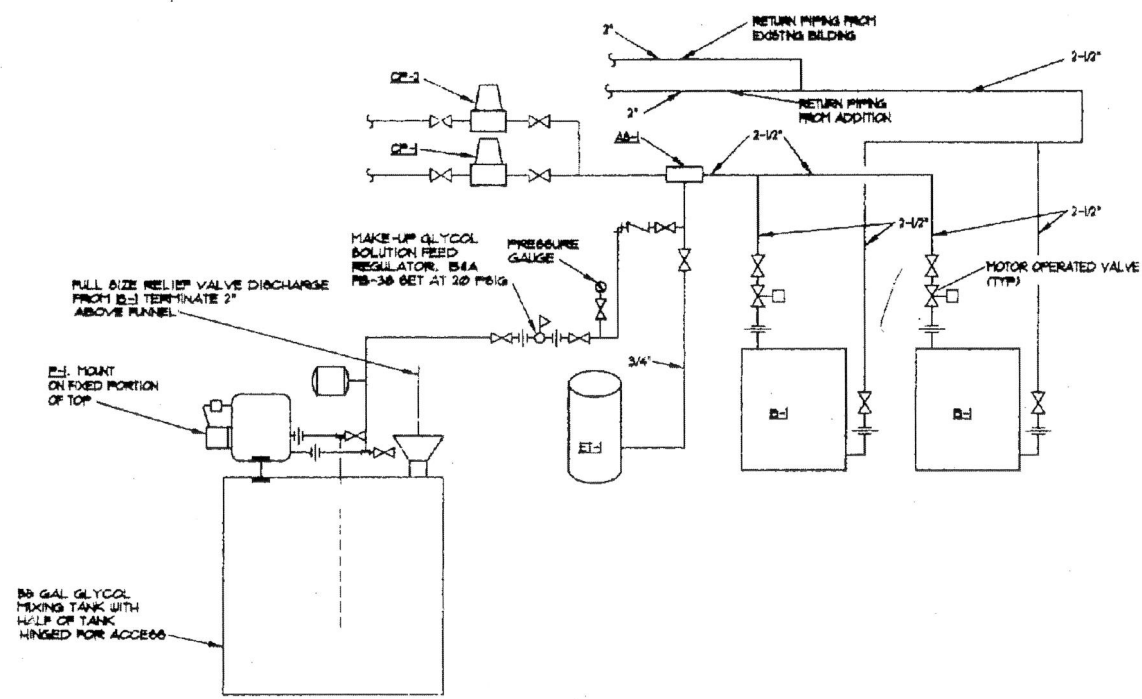
Chemicals in Lab Sump	
METHYL CARBITOL SOLVENT (FSII)	trimethylbenzenes
naphtholbenzein	vacuum pump oil
phenol	Viscosity bath oil
phenolphthalein	water standard
phosphate buffer solution	xylene
phosphoric acid	* (30-60% methanol, 10-20% 1-pentanol, 5-15% imadazole, 5-25% dodecyldimethylamine)
Hydrocarbon Samples	
ARC	HVY Kero
Asphalt	Incoming Crude
ASPHALT DEFOAMER	JP-4
BRT bottoms	JP-8
BRT feed	Kero raffinate
BRT ovhd	Kero recycle
Combined Return crude	LAGO
cooling kero	LSR
COREXIT 307 CORROSION INHIBITOR	LT Kero
CU1 stabilizer	LUBRIZOL 8195 GASOLINE ADDITIVE
Deprop bottoms	MDEA
Deprop feed	MONOETHANOL AMINE (MEA)
Desalted Crude	MORLIFE 5000 ASPHALT ADDITIVE
ETHYL ANTIOXIDANT 733 MDA 80	N Kero
ETHYL ANTIOXIDANT 733 PDA (D) 25	Naphtha
F-76	Naphtha raffinate
FHR Return Crude	Naphtha recycle
Full Kero	propylene glycol
Gasoline (unleaded)	S Kero,
HAGO	sulfolane
HITECH 6423 FUEL ADDITIVE	VGO
HITECH 6531 FUEL ADDITIVE	
Waters - samples & other	
Desalter Water	Effluent wastewater
Crude OVHD water	Influent wastewater
C1 Stabilizer ovhd water	Gravel pit water
Deprop ovhd water	Gallery Pond water
Vacuum ovhd water	Fire water
BRT ovhd water	Cooling water for Octane Engines
Recovery ovhd water	Ice machine water
Benzene stripper	HVAC condensate
Boiler water	Deionizer condensate
Kero stripper ovhd water	Cooling water for Bomb Calorimeter

Chemicals in Lab Sump	
Cooling water for boiler	
NALCO Chemicals	
NALclean 8940	Nalco EC 5816A
NALclean 8960	Nalco EC 5828A
Nalco 5376	Nalco EC 5830A
Nalco 5403	Nalco EC2043a
Nalco 5541	Nalco EC5345A
Nalco 5541	Nalco EC5370A
Nalco 5602	Nalco EC5407A
Nalco 7320	Nalco SO771 indicator
Nalco 8735	Nalco SO771 N-2 Titrant
Nalco EC 5419A	Nalco SO780MQT-1
Detergents & cleaners	
409	Janitorial chemicals
A-33 Dry respirator cleaner	Joy
alcojet	neodisher A8
alcotabs	neodisher EM
citrus degreaser	neodisher N
Clorox	neodisher Z
Contrad 70	RBS solution
Contrex	Windex



NEW LAB FLOOR PLAN

FLOOR PLAN		
SCALE: 1/4" = 1'-0"	APPROVED BY:	DRAWN BY: HUNLEY
DATE:	REVISED:	
		DRAWING NUMBER:
		118-2



1 BOILER PIPING SCHEMATIC
NO SCALE

EQUIPMENT SCHEDULE

SYMBOL	ITEM	CAPACITY/SIZE	HP	ELEC.	MANUFACTURER & MODEL	REMARKS
B-1	BOILER	434 FISH GROSS OUTPUT, 5.8 GPM FIRMING ON NO. 2 FUEL OIL	1/8	115V/60/3A	BURNHAM MODEL V-304	
AB-1	AIR SEPARATOR	2-1/2"			TACO MODEL 438	
ET-1	EXPANSION TANK	21 GALLON VOLUME, 10 GALLON ACCEPTANCE VOLUME			AMTROL MODEL 8X-40V EXTROL	PRESSURIZE TO 6 PSIG
CP-1	CIRCULATING PUMP	48 GPM @ 15 FT. TDH	1/2	115V/60/3A	GRUNDOS MODEL UHC 80-80, RUN ON RFD. 3	
CP-2	CIRCULATING PUMP	48 GPM @ 15 FT. TDH	1/2	115V/60/3A	GRUNDOS MODEL UHC 80-80	
P-1	GLYCOL MAKE-UP PUMP	6.80 GPM @ 20 PSIG	1/2	115V/60/3A	GOULDS MODEL 3030S AQUA-AIR	
UH-1	UNIT HEATER	45.5 FISH, 180° EUT, 20° TEMP. DROP, 4.3 GPM, 0.75 FT. UPD	1/4	115V/60/3A	DUNHAM BUSH MODEL H300C	
FTR-1	FINNED TUBE RADIATION	1000 BTU/HF @ 100° AUT			DUNHAM BUSH MODEL 642 WITH TB44X4-48 ELEMENT	
AHU-1	AIR HANDLER	2345 CFM @ 1.5" SP	2.2	200V/3/60/7.5	MODULAY MODEL CAH006PAC WITH PLAT IN TERN MIXING BOX, HTG AND CLG COIL, INTERNALLY ISOLATED	
HC-1	HEATING COIL	2345 CFM, 6" TO 8" WITH 21.4 GPM, 180° EUT, 20° TEMP. DROP, 0.8" AFD, 2.1 FT. UPD			MODULAY MODEL BAH002B, LOCATED IN AHU-1	
CC-1	COOLING COIL	2345 CFM, 6" TO 8" WITH 11.5 GPM, 180° EUT, 20° TEMP. DROP, 0.8" AFD, 0.18 FT. UPD			MODULAY MODEL BAH002B, LOCATED IN AHU-1	
PHC-1	PREHEAT COIL	2345 CFM, 6" TO 8" WITH 11.5 GPM, 180° EUT, 20° TEMP. DROP, 0.8" AFD, 0.18 FT. UPD			MODULAY MODEL BAH002B, SIZE 30x24	
CU-1	CONDENSING UNIT	1.5 TONS COOLING	27.7 AMP	200V/3/60	YORK MODEL HDB078	
VF-1	VENTILATING FAN	1000 CFM @ 0.25" SP	1/8	115V/60	FRONT FAN PROPELLER FAN WITH MOTORIZED DAMPER, WALL SLEEVE, REAR GUARD	
L-1	LOUVER	SIZE AS INDICATED ON PLANS			MURKIN MODEL BLF315D	
BD-1	BAROMETRIC DAMPER	SIZE AS INDICATED ON PLANS			MURKIN MODEL BDG WITH STATIC PRESSURE CONTROL AND REAR SCREEN	
CV-1	PHC-1 CONTROL VALVE	2 WAY VALVE, CV=16				
CV-2	HC-1 CONTROL VALVE	2-WAY VALVE, CV=10				

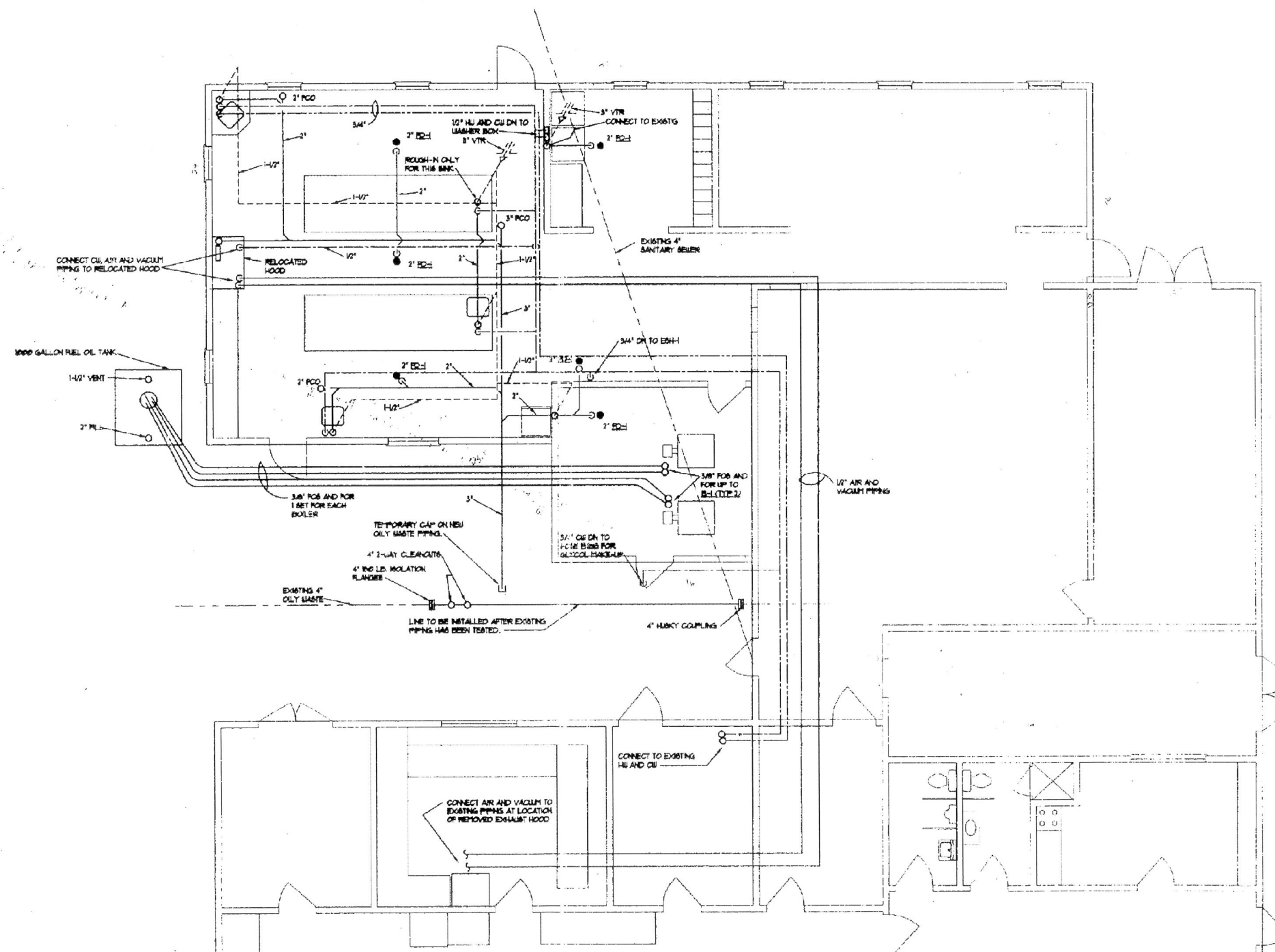
SEQUENCE OF OPERATION

1. BOILER B-1 SHALL OPERATE IN ACCORDANCE WITH ITS PACKAGED CONTROL SYSTEM. THE BOILERS SHALL RUN IN A LEAD-LAG MODE, WITH THE SECOND BOILER OPERATING WHENEVER THE FIRST BOILER IS NOT ABLE TO MAINTAIN WATER TEMPERATURE. ALTERNATE LEAD-LAG FIRING ON EACH START. TWO POSITION CONTROL VALVE ASSOCIATED WITH EACH BOILER SHALL CLOSE WHEN LAG BOILER IS NOT RUNNING.
2. CIRCULATING PUMP CP-1 SHALL RUN WHENEVER THE OUTSIDE TEMPERATURE IS BELOW 60 DEGREES F.
3. CIRCULATING PUMP CP-2 CONTROLS SIMILAR TO CP-1.
4. AIR HANDLING UNIT AHU-1 SHALL RUN CONTINUOUSLY. PREHEAT COIL CONTROL VALVE, CV-1, SHALL MODULATE TO MAINTAIN LEAVING AIR TEMPERATURE OF 9 DEGREES F. THE MIXING DAMPERS SHALL MODULATE TO MAINTAIN BUILDING STATIC PRESSURE OF 0.01 INCHES. IN ADDITION, HEATING COIL HC-1 CONTROL VALVE CV-2 AND THE MIXING DAMPERS SHALL MODULATE IN SEQUENCE TO MAINTAIN ROOM AIR TEMPERATURE, SET POINT 70 DEGREES F. RELIEF DAMPER SHALL MODULATE OPEN WHENEVER THE BUILDING PRESSURE RISES ABOVE 0.05 INCHES.
5. CONDENSING UNIT CU-1 CONTROL SYSTEM SHALL BE ACTIVATED WHENEVER THE OUTSIDE AIR TEMPERATURE IS ABOVE 50 DEGREES.
6. EXHAUST HOOD SHALL RUN FROM MANUAL SWITCH LOCATED ADJACENT TO HOOD.
7. PUMP P-1 SHALL RUN TO MAINTAIN HYDRONIC SYSTEM PRESSURE AS DETERMINED BY PUMP PRESSURE SWITCH.
8. FINNED TUBE RADIATION ZONE VALVE SHALL CYCLE OPEN ON CALL FOR HEAT AS DETERMINED BY ROOM THERMOSTAT.
9. UNIT HEATER UH-1 FAN SHALL RUN ON A CALL FOR HEAT FROM THE ROOM THERMOSTAT. SET POINT 70 DEGREES. CONTINUOUS FLUID FLOW THROUGH UNIT HEATER.
10. VENTILATING FAN VF-1 SHALL RUN AND DAMPER SHALL OPEN ON CALL FOR COOLING FROM ROOM THERMOSTAT. SET POINT 75 DEGREES.
11. UH-1 IS CONTROLLED FROM ROOM THERMOSTAT. VENT IS CONTROLLED OFF SAME THERMOSTAT FOR COOLING MECHANICAL ROOM.

SPECIFICATIONS

1. FURNISH ALL EQUIPMENT, MATERIAL AND LABOR TO PROVIDE COMPLETE AND OPERATING MECHANICAL SYSTEMS.
2. ALL WORK TO BE DONE IN ACCORDANCE WITH LATEST EDITION OF UPC, UBC, UPC, ADCC, SMACNA, ASHRAE AS APPLICABLE.
3. ALL ELECTRIC MOTORS AND STARTERS SHALL BE UL LISTED AND BEAR THE UL LABEL. MOTOR STARTERS SHALL BE FURNISHED BY THE MECHANICAL CONTRACTOR.
4. PERFORM AIR AND WATER BALANCE ON VENTILATION AND HYDRONIC SYSTEMS TO WITHIN 1% DESIGN CRITERIA AND PROVIDE A COMPLETE BALANCE REPORT FOR ENGINEER'S REVIEW.
5. DOMESTIC WASTE AND VENT PIPING BELOW GRADE SHALL BE STANDARD WEIGHT HUB AND BUST CAST IRON PIPE WITH "TYPICAL" JOINTS OR NO-HUB CAST IRON PIPE WITH NEOPRENE COLLAR AND STAINLESS STEEL BAND AND SHALL BE INSTALLED IN ACCORDANCE WITH UNIFORM PLUMBING CODE. ALL WASTE AND VENT PIPING ABOVE GRADE SHALL BE TYPE DWV COPPER TUBING.
6. ALL OILY WASTE PIPING BELOW GRADE SHALL BE BLACK SCH. 40 PIPE WITH WELD FITTINGS AND WELDED JOINTS IN ACCORDANCE WITH ADCC REQUIREMENTS AND QUA-300.3 SECTION IX, AS PER BOILER AND PRESSURE VESSEL CODE. VENT PIPING FOR OILY WASTE SYSTEM SHALL BE CAST IRON PIPE AND FITTINGS WITH NO-HUB FITTINGS AND COUPLINGS. OILY WASTE SHALL BE WRAPPED WITH HEAT TAPE AND GASEMOCALLY PROTECTED.
7. COPPER TUBING FOR FUEL OIL PIPING BELOW GRADE SHALL BE TYPE K1 SOFT DRAIN TUBING WITH FLARE FITTINGS OR UNOT COPPER FITTINGS AND 1000 F SILVER SOLDER JOINTS.
8. COPPER TUBING FOR DOMESTIC WATER SYSTEMS SHALL BE TYPE L1 HARD DRAIN TUBING WITH UNOT COPPER FITTINGS AND 90-9 SOLDER JOINTS.
9. HEATING PIPING SHALL BE TYPE L1 HARD DRAIN COPPER WITH UNOT COPPER FITTINGS AND 90-9 SOLDER JOINTS.
10. INSULATE HOT AND COLD DOMESTIC WATER LINES AND HEATING WATER LINES WITH 1" THICK FIBERGLASS INSULATION WITH VAPOR BARRIER JACKET.
11. INSULATE ALL OUTSIDE AIR INTAKE DUCTS WITH 1" THICK, 3 LB. DENSITY RIGID FIBERGLASS. INSULATE EXHAUST DUCTS WITH 1" THICK RIGID FIBERGLASS. ALL DUCT INSULATION SHALL HAVE FIK JACKET.
12. HYDRONIC HEATING SYSTEM SHALL BE FILLED WITH A BLEND OF 60% PROPYLENE GLYCOL AND 40% WATER.
13. ALL DUCTWORK SHALL BE INSTALLED IN ACCORDANCE WITH SMACNA STANDARDS.
14. EXHAUST LOUVERS SHALL BE SIZED TO PREVENT MOISTURE ENTRAINMENT AND TO ALLOW NO MORE THAN 0.1" WG PRESSURE DROP.
15. TEMPERATURE CONTROLS SHALL BE ELECTROELECTRONIC AS REQUIRED TO PROVIDE A COMPLETE AND OPERABLE SYSTEM.
16. COORDINATE LOCATION AND HEIGHT OF ALL FINNED TUBE RADIATION AND LOCATIONS OF ELECTRICAL WALL OUTLETS.

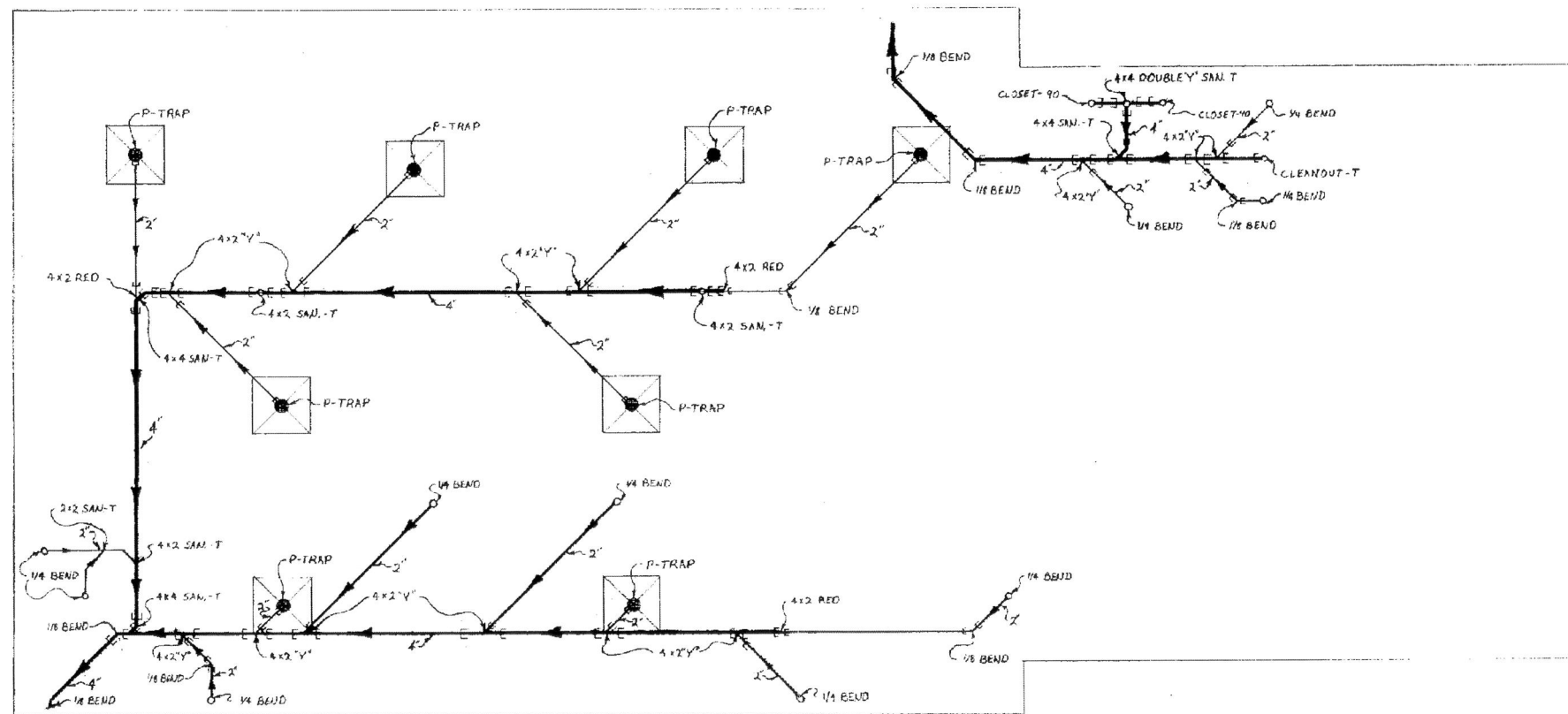
REVISIONS	DATE	DESCRIPTION
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PLUMBING PLAN
SCALE 1/4"=1'-0"

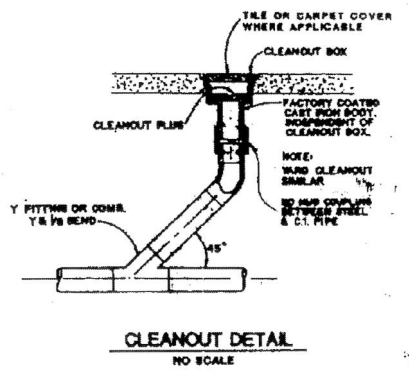
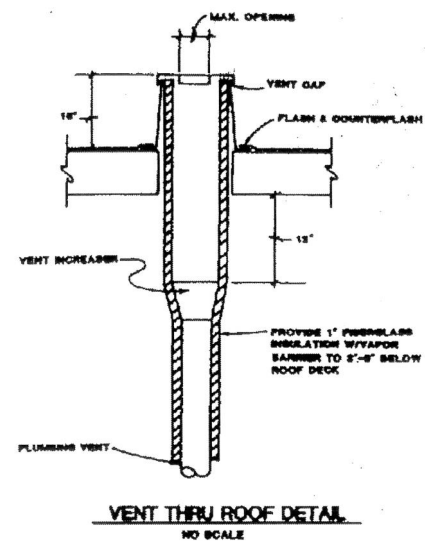
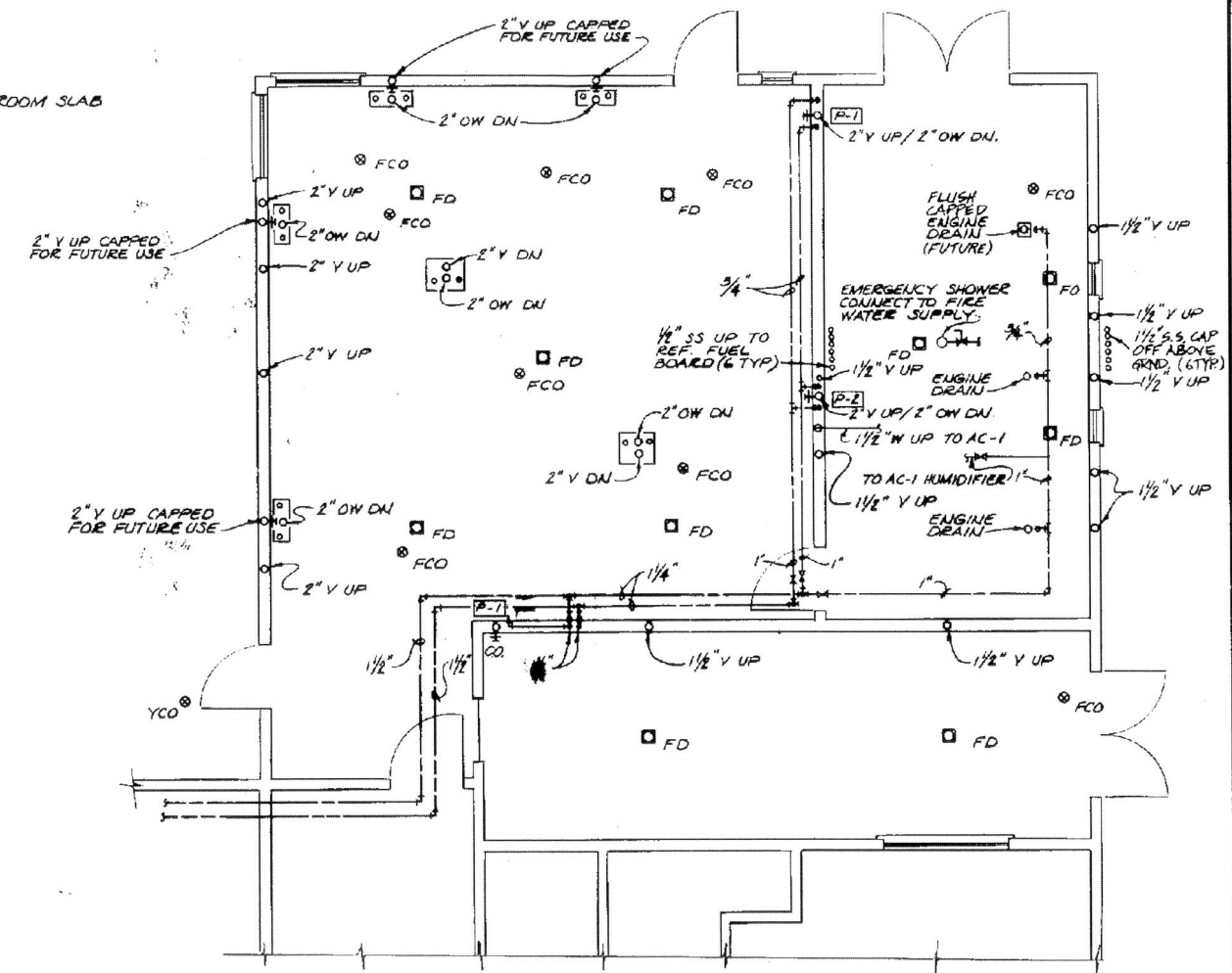
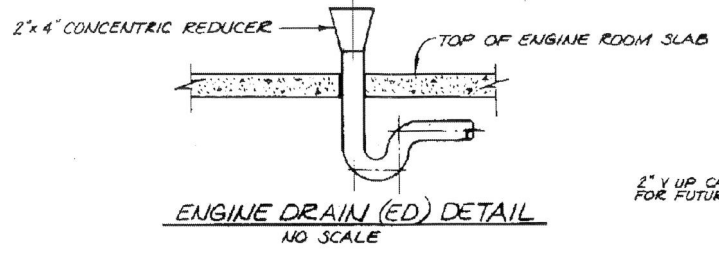
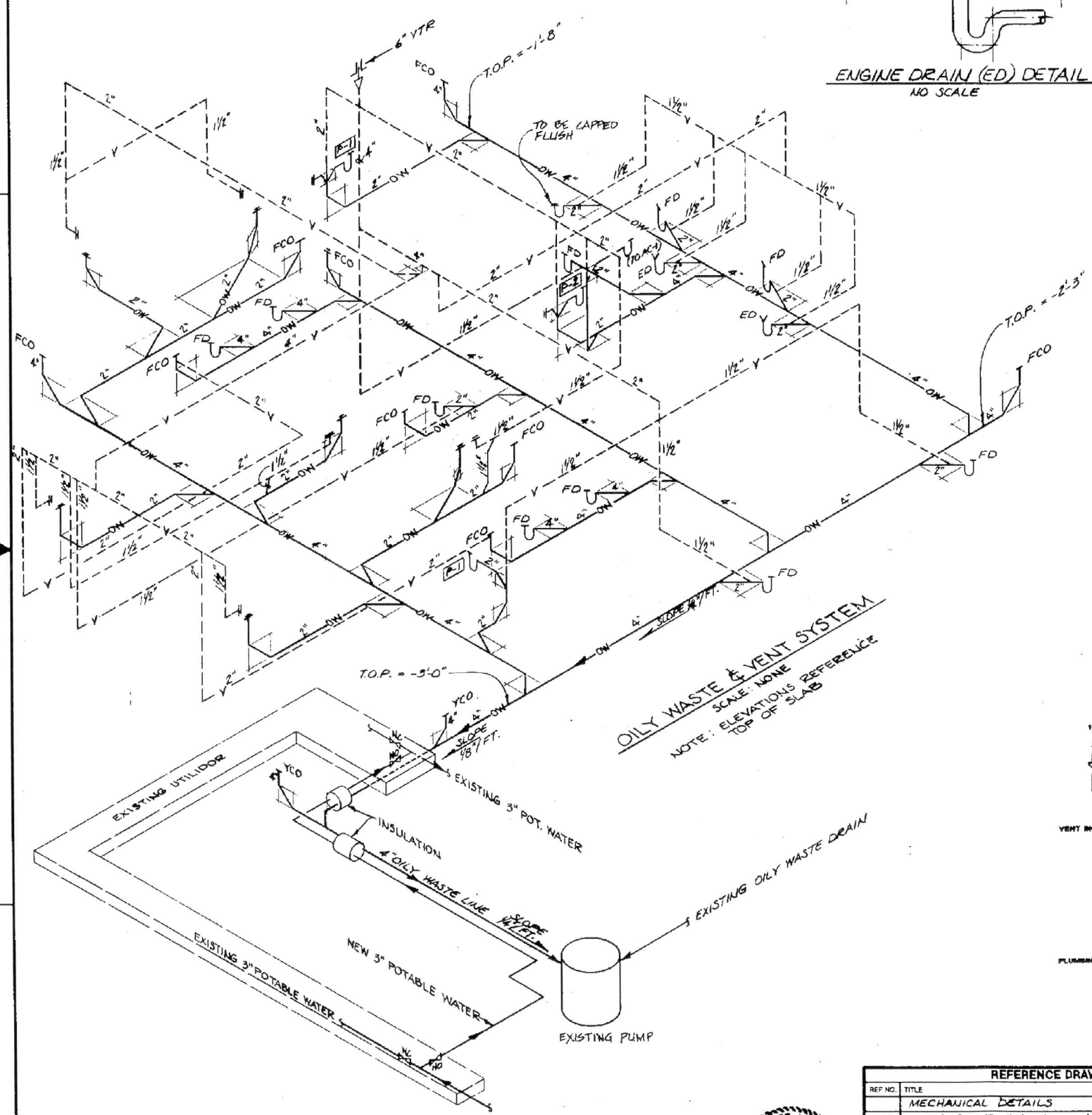


REVISION	DATE	DESCRIPTION
1	6/15/90	MAPCO REFINERY LABORATORY EXPANSION
2	6/15/90	PLUMBING PLAN
3	6/15/90	M-E-B ENGINEERING SERVICES
4	6/15/90	M-2



SCALE:		
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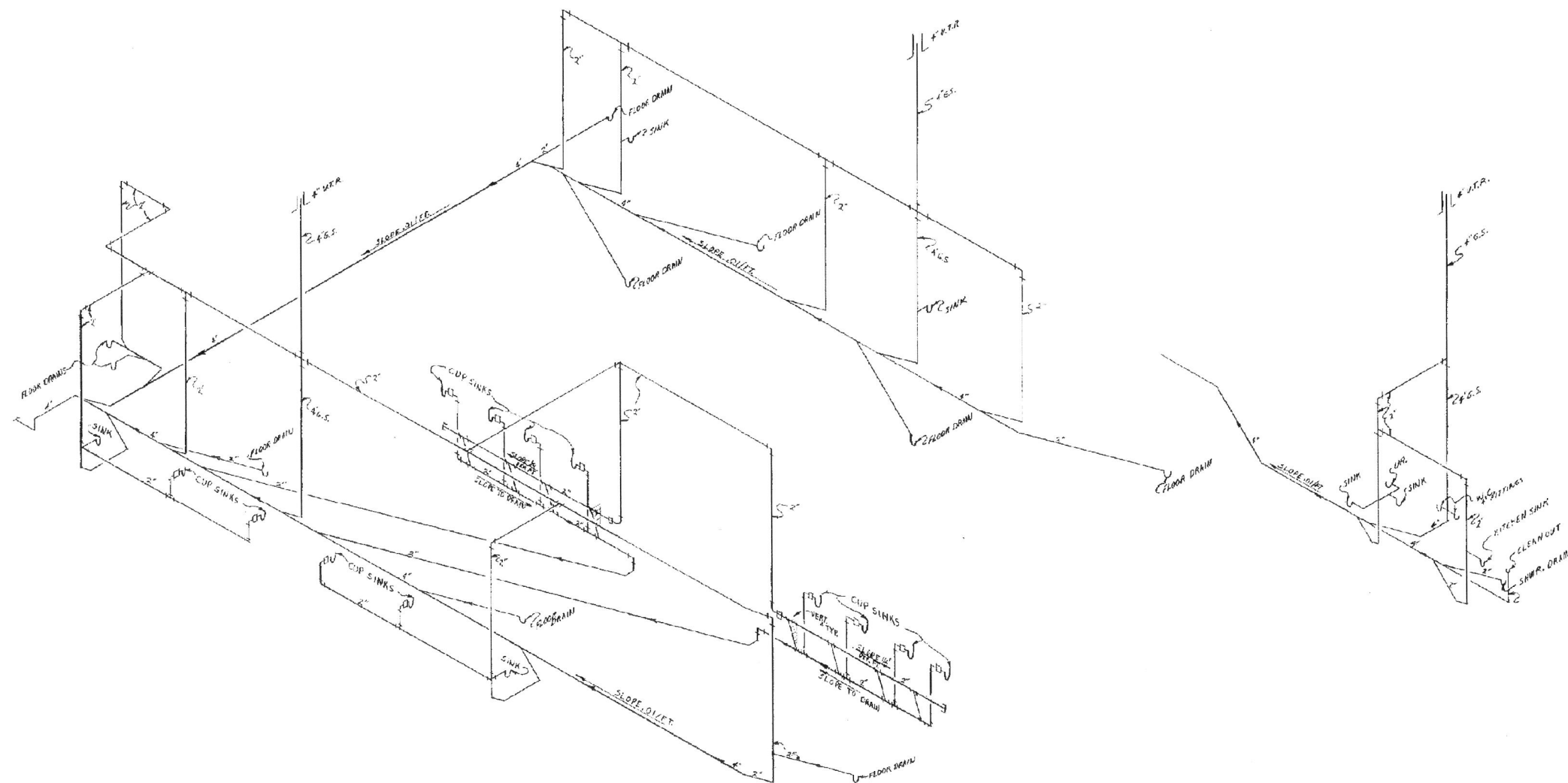


REFERENCE DRAWINGS			REVISIONS			ISSUE RECORD		
REF. NO.	TITLE	DRAWING NO.	REV.	DATE	BY	APPROVED	DATE	FOR
1	MECHANICAL DETAILS	D-10-M1003	1	10/1/85	WST	ISSUED FOR APPROVAL		
2	UNDERGROUND PIPING PLAN	D-10-M1000	1	10/1/85	WST	ISSUED FOR CONSTRUCTION		
3								
4								
5								
6								
7								
8								

PROJECT NO. 13081-85E		SCALE AS SHOWN	
PROJECT		DATE 10/1/85	
DRAWING		DRAWN	
ISS. NO. D-10-M1001		REV. 0	
		CHECKED WST	

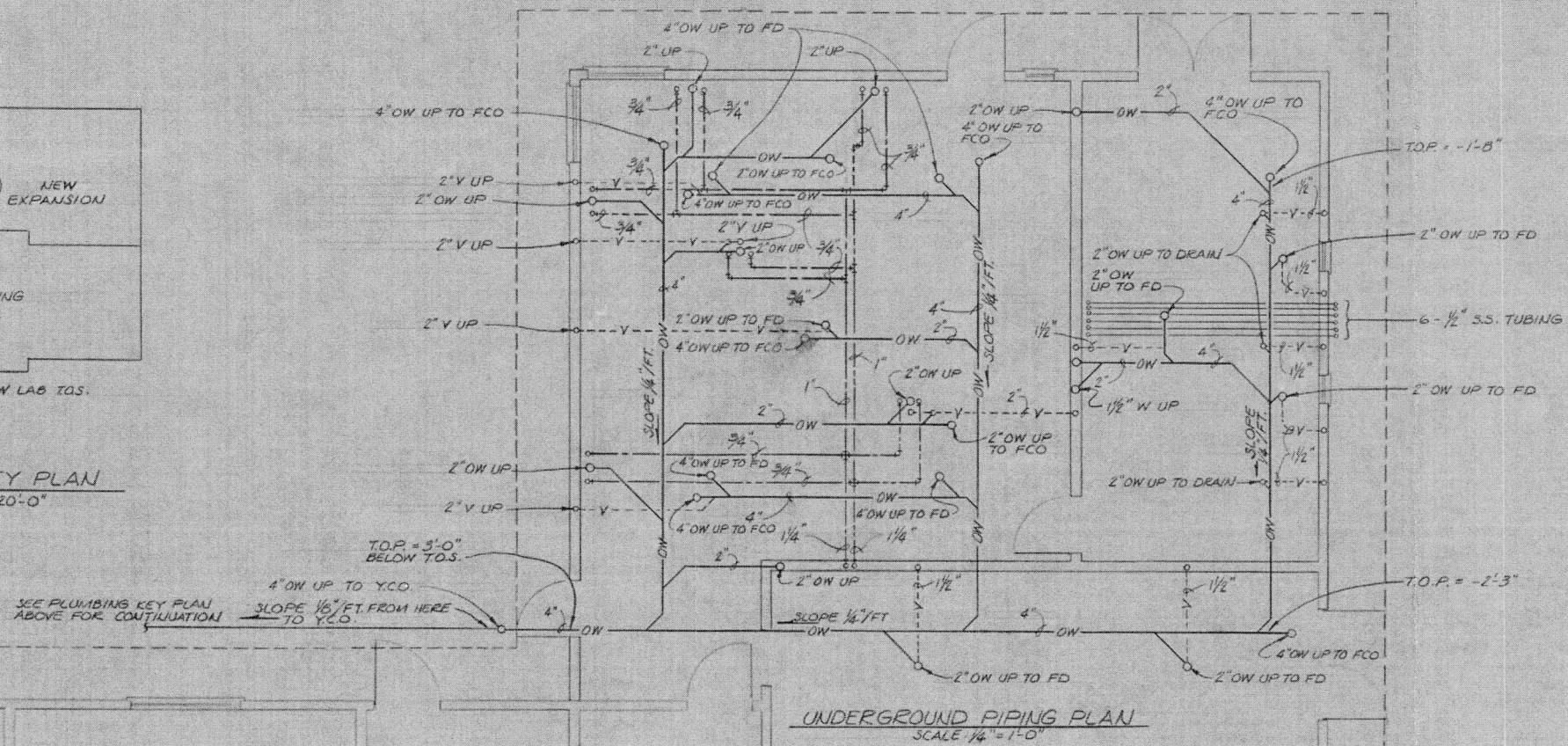
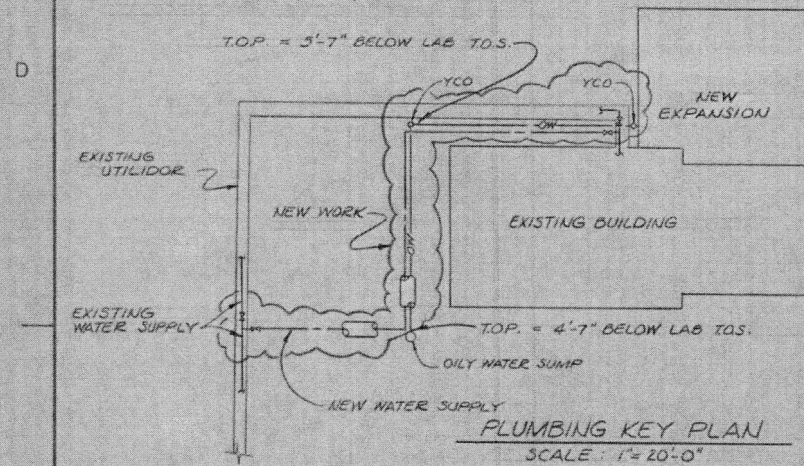
MAPCO PETROLEUM INC.
NORTH POLE REFINERY
NORTH POLE, ALASKA

1985 LABORATORY EXPANSION
PLUMBING PLAN & DETAILS



PLUMBING ISOMETRIC LAYOUT		
SCALE:	APPROVED BY:	DRAWN BY:
DATE:		REVISED:
LAB		DRAWING NUMBER:
		118-4

INSTALL NEW VALVES IN WATER SUPPLY LINE AND REROUTE AS SHOWN. THE NEW WATER SUPPLY LINE WILL SERVE AS A HEAT TRACER TO KEEP THE OLD WATER SEWER LINE FROM THE NEW EXPANSION FROM FREEZING.



_____OW_____	OILY WASTES
_____V_____	VENT
_____	COLD WATER SUPPLY
_____	HOT WATER SUPPLY
ED	ENGINE DRAIN
FCD	FLOOR CLEANOUT
FD	FLOOR DRAIN
YCD	YARD CLEANOUT

[illegible]

Flint Hills Resources Alaska

NPR Laboratory Underground Piping Failure Evaluation

6/23/2010 Rev 0

7/21/10 Rev 1



Table of Contents

- I. Root cause analysis
- II. Leak rate estimation
- III. Chemical list
- IV. Leak test description
- V. Summary
- VI. Appendix A D-10-M1001 Lab piping drawing.
- VII. Appendix B Chemical compatibility for Neoprene
- VIII. Appendix C Drain pictures.
- IX. Appendix D Root Cause Map

I. Root Cause Analysis

A root cause analysis for the Flint Hills Resources Alaska (FHR), North Pole Refinery (NPR) laboratory drain piping was completed to determine the mechanism of failure on the lab sump drain piping. The root cause for the piping failure was found to be "Design not to Specification" on the drain piping connections at the time of installation in approximately 1985. This determination is based on a review of the original design information on the drain systems. The cast iron drain piping was put together during installation with No-hub style neoprene pipe couplings that are incompatible with certain hydrocarbons and can degrade when exposed to these hydrocarbons. See appendix A for building drain system drawings. See appendix B for chemical compatibility for Neoprene. Typical lab piping systems use Duriron high silicon cast iron piping and the appropriate couplings or glass piping systems manufactured by Corning or Kimax/Schott.

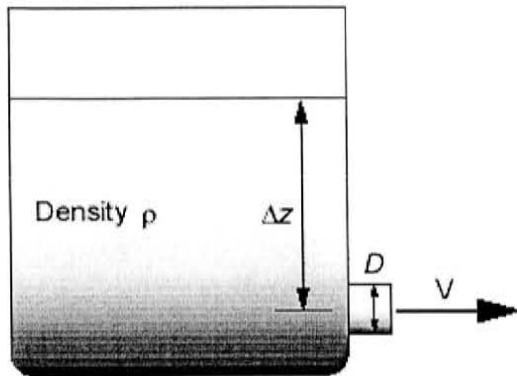
The piping drain systems were inspected by Keith Bradshaw from Fairbanks Pumping and Thawing on May 11, 2010. All of the piping drain systems are under the floor slab of the laboratory. Therefore, a flexiprobe P330 sewer camera was used to check the inside of the piping system. The flexiprobe camera was pushed inside of the piping system to the extent possible to inspect the piping internally for defects. The vertical sections of the piping was the only portion of the drain system which was clean enough to visually inspect with the camera. No-hub couplings in the area inspected were found to be deformed and in bad condition which would indicate leaking at the couplings inspected. See pictures in Appendix C.

II. Leak Rate Estimation

Objective: The objective of this section is to calculate the leak rate and the approximate leak orifice given the measured field data.

Background: A hydrostatic test using water was conducted on the under floor drain piping system at the NPR laboratory (lab) during the week of May 9th 2010. The underground drains were blinded and plugged at the outlet of the lab building. Water was used to fill the drain system liquid full. Air was removed by opening the cleanouts and observing the liquid level in all of the floor drains. When the water level reached the top of the floor drains, a timed test was started to measure loss of level over a given period of time. It was observed that the water level in the piping system dropped at a rate of 1 inch per hour. Measurements were taken with a tape measure at the top of the drain to the water level. Marks were made at the water levels with a paint pen to confirm the measurements.

Leak Rate Calculation



Given Bernoulli's equation for a small tank the combined equivalent leak orifice can be calculated.

$$\rho g z_{surface} + p_{atm} = \frac{1}{2} \rho V_{jet}^2 + \rho g z_{spout} + p_{atm}$$

$$V_{jet} = \sqrt{2g(z_{surface} - z_{spout})} = \sqrt{2g\Delta z}$$

$$Q = A_{jet} V_{jet} = C A_{spout} V_{jet} [1],[2]$$

P = pressure V = velocity A = area of orifice C=nozzle constant ρ =density g=gravitational constant

Assumptions:

- 1) Pressure inside the drain pipe is the same as outside the drain pipe.
- 2) The piping system can be calculated as a small tank system
- 3) Orifice constant 0.9
- 4) Leaked fluid has low viscosity and is incompressible.

LEAK RATE CALCULATION

DRAINS	4	2	1.5	INCHES
TOTAL DRAINS	12	19	2	
DRAIN AREA	12.56637	3.141593	1.767146	INCHES^2
DRAIN HEIGHT	1	1	1	INCH
DRAIN VOLUME	12.56637	3.141593	1.767146	INCHES^3
TOAL DRAIN VOLUME	150.7964	59.69026	3.534292	INCHES^3
SUM OF DRAIN VOLUME	214.021	INCHES^3		
GALLONS	0.926711	GALLONS		
TEST DURATION	60	MINUTES		
LEAK RATE	0.015445	GALLONS PER MINUTE		

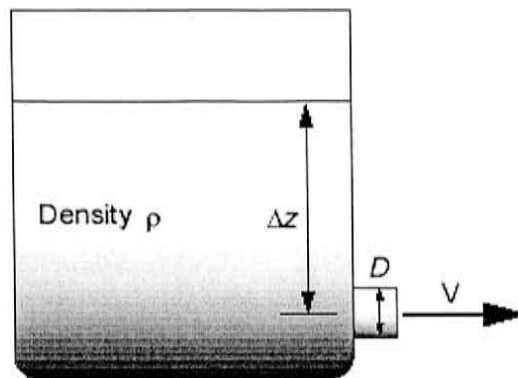
ORIFICE CALCULATION

0.9 CONSTANT K
 1 FT H2O
 0.000686 INCH SQ ORIFICE AREA
 0.029564 INCH ORIFICE DIAMETER

References

- 1) Cameron Hydraulic Data, C.C. Heald Nineteenth Edition
- 2) www.efunda.com/formulae/fluids/draining_tank.cfm#calc

Calculation Back Check



Inputs

Depth of spout, Δz :

Fluid density, ρ :

Spout exit diameter, D :

Discharge Coefficient, C :

Answers

Exit Velocity, V :

Volume Flowrate: Select desired output units for next calculation.

Mass Flowrate:

III. Chemical List

IV. Leak test description

The under floor drain piping system was plugged at the outlet of the building. Water was then used to fill the piping. The cleanouts were opened to make sure all of the air was removed from the drains. The piping system was then filled to the top of the drains. All of the drains were observed to verify full of water prior to beginning the test. A timed test was then completed. The leak rate was determined to be 1 inch per hour based on water loss of a specific period of time.

V. Summary

A root cause analysis was completed. The root cause for the piping system failure was determined to be incorrect design specifications at the time of installation in approximately 1985. Drawings were found that indicated No-hub style connectors were originally installed. Fairbanks Pumping and Thawing was used to investigate the condition of the inside of the piping. A sewer camera was used to look down inside the piping system. The No-hub connectors were found to be in poor condition. Naphtha and toluene are on the list of chemicals disposed of down the drain system and would have been disposed since installation first occurred. These chemicals are known to be aggressive toward neoprene. Leak rate calculations were completed. The approximate leak rate was found to be in the order of 0.015 gallons per minute or 21.6 gallons per day assuming liquid full for 24 hours. This leak rate is for a 100% full drain piping system and therefore is highly conservative. During normal operations the drain piping system would be intermittently used, would be open channel flow and not liquid full. The leak rate during normal use is affected by many variables like amount of time utilized and volume placed into the system so it cannot be calculated with any degree of accuracy. FHR has discontinued use and abandoned the lab drain piping system. A new temporary above ground steel piping system has been installed and is being added to the above ground piping inspection program. A long term project will be designed and installed at a later date.

Appendix A Lab piping drawings.

Appendix B Chemical compatibility for Neoprene

Chemical Compatibility Results [Revise original search](#)

 The Material Selected **Neoprene**

 Compatibility Level Selected **D-Severe Effect**

The chemicals which match your search results are listed below:

Chemical	Compatibility
<u>Acetate Solvent</u>	D-Severe Effect
<u>Acetic Acid, Glacial</u>	D-Severe Effect
<u>Acetyl Chloride (dry)</u>	D-Severe Effect
<u>Alcohols:Diacetone</u>	D-Severe Effect
<u>Ammonium Bifluoride</u>	D-Severe Effect
<u>Amyl Acetate</u>	D-Severe Effect
<u>Amyl Chloride</u>	D-Severe Effect

<u>Aniline</u>	D-Severe Effect
<u>Aniline Hydrochloride</u>	D-Severe Effect
<u>Aqua Regia (80% HCl, 20% HNO3)</u>	D-Severe Effect
<u>Arochlor 1248</u>	D-Severe Effect
<u>Aromatic Hydrocarbons</u>	D-Severe Effect
<u>Asphalt</u>	D-Severe Effect
<u>Benzaldehyde</u>	D-Severe Effect
<u>Benzene</u>	D-Severe Effect
<u>Benzol</u>	D-Severe Effect
<u>Benzyl Chloride</u>	D-Severe Effect
<u>Bleaching Liquors</u>	D-Severe Effect
<u>Boric Acid</u>	D-Severe Effect
<u>Bromine</u>	D-Severe Effect
<u>Buttermilk</u>	D-Severe Effect

<u>Butyl Amine</u>	D-Severe Effect
<u>Butyl Ether</u>	D-Severe Effect
<u>Butyl Phthalate</u>	D-Severe Effect
<u>Butylacetate</u>	D-Severe Effect
<u>Butylene</u>	D-Severe Effect
<u>Butyric Acid</u>	D-Severe Effect
<u>Calcium Hypochlorite</u>	D-Severe Effect
<u>Carbolic Acid (Phenol)</u>	D-Severe Effect
<u>Carbon Bisulfide</u>	D-Severe Effect
<u>Carbon Disulfide</u>	D-Severe Effect
<u>Carbon Tetrachloride</u>	D-Severe Effect
<u>Carbon Tetrachloride (dry)</u>	D-Severe Effect
<u>Carbon Tetrachloride (wet)</u>	D-Severe Effect
<u>Carbonic Acid</u>	D-Severe Effect

<u>Chlorinated Glue</u>	D-Severe Effect
<u>Chlorine Water</u>	D-Severe Effect
<u>Chlorine, Anhydrous Liquid</u>	D-Severe Effect
<u>Chloroacetic Acid</u>	D-Severe Effect
<u>Chlorobenzene (Mono)</u>	D-Severe Effect
<u>Chlorobromomethane</u>	D-Severe Effect
<u>Chloroform</u>	D-Severe Effect
<u>Chlorosulfonic Acid</u>	D-Severe Effect
<u>Chromic Acid 10%</u>	D-Severe Effect
<u>Chromic Acid 30%</u>	D-Severe Effect
<u>Chromic Acid 5%</u>	D-Severe Effect
<u>Chromic Acid 50%</u>	D-Severe Effect
<u>Citric Oils</u>	D-Severe Effect
<u>Cream</u>	D-Severe Effect

<u>Cresols</u>	D-Severe Effect
<u>Cresylic Acid</u>	D-Severe Effect
<u>Cyclohexane</u>	D-Severe Effect
<u>Cyclohexanone</u>	D-Severe Effect
<u>Diacetone Alcohol</u>	D-Severe Effect
<u>Dichlorobenzene</u>	D-Severe Effect
<u>Dichloroethane</u>	D-Severe Effect
<u>Diethyl Ether</u>	D-Severe Effect
<u>Dimethyl Aniline</u>	D-Severe Effect
<u>Dimethyl Formamide</u>	D-Severe Effect
<u>Diphenyl Oxide</u>	D-Severe Effect
<u>Ether</u>	D-Severe Effect
<u>Ethyl Acetate</u>	D-Severe Effect
<u>Ethyl Benzoate</u>	D-Severe Effect

<u>Ethyl Ether</u>	D-Severe Effect
<u>Ethylene Chloride</u>	D-Severe Effect
<u>Ethylene Dichloride</u>	D-Severe Effect
<u>Ethylene Oxide</u>	D-Severe Effect
<u>Freonr 11</u>	D-Severe Effect
<u>Furan Resin</u>	D-Severe Effect
<u>Furfural</u>	D-Severe Effect
<u>Grape Juice</u>	D-Severe Effect
<u>Grease</u>	D-Severe Effect
<u>Hydrobromic Acid 100%</u>	D-Severe Effect
<u>Hydrobromic Acid 20%</u>	D-Severe Effect
<u>Hydrochloric Acid 100%</u>	D-Severe Effect
<u>Hydrofluoric Acid 100%</u>	D-Severe Effect
<u>Hydrofluoric Acid 50%</u>	D-Severe Effect

<u>Hydrofluoric Acid 75%</u>	D-Severe Effect
<u>Hydrogen Peroxide 10%</u>	D-Severe Effect
<u>Hydrogen Peroxide 100%</u>	D-Severe Effect
<u>Hydrogen Peroxide 30%</u>	D-Severe Effect
<u>Hydrogen Peroxide 50%</u>	D-Severe Effect
<u>Iodine</u>	D-Severe Effect
<u>Isopropyl Acetate</u>	D-Severe Effect
<u>Isopropyl Ether</u>	D-Severe Effect
<u>Isotane</u>	D-Severe Effect
<u>Jet Fuel (JP3, JP4, JP5)</u>	D-Severe Effect
<u>Ketones</u>	D-Severe Effect
<u>Lacquer Thinners</u>	D-Severe Effect
<u>Lacquers</u>	D-Severe Effect
<u>Lard</u>	D-Severe Effect

<u>Lubricants</u>	D-Severe Effect
<u>Maleic Acid</u>	D-Severe Effect
<u>Maleic Anhydride</u>	D-Severe Effect
<u>Malic Acid</u>	D-Severe Effect
<u>Melamine</u>	D-Severe Effect
<u>Methyl Acetone</u>	D-Severe Effect
<u>Methyl Bromide</u>	D-Severe Effect
<u>Methyl Butyl Ketone</u>	D-Severe Effect
<u>Methyl Chloride</u>	D-Severe Effect
<u>Methyl Ethyl Ketone</u>	D-Severe Effect
<u>Methyl Ethyl Ketone Peroxide</u>	D-Severe Effect
<u>Methyl Isobutyl Ketone</u>	D-Severe Effect
<u>Methyl Isopropyl Ketone</u>	D-Severe Effect
<u>Methyl Methacrylate</u>	D-Severe Effect

<u>Monoethanolamine</u>	D-Severe Effect
<u>Morpholine</u>	D-Severe Effect
<u>Naphtha</u>	D-Severe Effect
<u>Naphthalene</u>	D-Severe Effect
<u>Nitric Acid (20%)</u>	D-Severe Effect
<u>Nitric Acid (50%)</u>	D-Severe Effect
<u>Nitric Acid (Concentrated)</u>	D-Severe Effect
<u>Nitrobenzene</u>	D-Severe Effect
<u>Nitromethane</u>	D-Severe Effect
<u>Nitrous Acid</u>	D-Severe Effect
<u>Oils:Aniline</u>	D-Severe Effect
<u>Oils:Anise</u>	D-Severe Effect
<u>Oils:Bay</u>	D-Severe Effect
<u>Oils:Bone</u>	D-Severe Effect

<u>Oils:Citric</u>	D-Severe Effect
<u>Oils:Fuel (1, 2, 3, 5A, 5B, 6)</u>	D-Severe Effect
<u>Oils:Lemon</u>	D-Severe Effect
<u>Oils:Linseed</u>	D-Severe Effect
<u>Oils:Palm</u>	D-Severe Effect
<u>Oils:Peppermint</u>	D-Severe Effect
<u>Oils:Pine</u>	D-Severe Effect
<u>Oils:Sesame Seed</u>	D-Severe Effect
<u>Oils:Silicone</u>	D-Severe Effect
<u>Oils:Sperm (whale)</u>	D-Severe Effect
<u>Oils:Tanning</u>	D-Severe Effect
<u>Oils:Turbine</u>	D-Severe Effect
<u>Oleum 100%</u>	D-Severe Effect
<u>Oleum 25%</u>	D-Severe Effect

<u>Oxalic Acid (cold)</u>	D-Severe Effect
<u>Palmitic Acid</u>	D-Severe Effect
<u>Perchloroethylene</u>	D-Severe Effect
<u>Phenol (10%)</u>	D-Severe Effect
<u>Phenol (Carbolic Acid)</u>	D-Severe Effect
<u>Phosphoric Acid (crude)</u>	D-Severe Effect
<u>Phosphorus Trichloride</u>	D-Severe Effect
<u>Plating Solutions, Chromium Plating: Barrel Chrome Bath 95°F</u>	D-Severe Effect
<u>Plating Solutions, Chromium Plating: Black Chrome Bath 115°F</u>	D-Severe Effect
<u>Plating Solutions, Chromium Plating: Chromic-Sulfuric Bath 130°F</u>	D-Severe Effect
<u>Plating Solutions, Chromium Plating: Fluoride Bath 130°F</u>	D-Severe Effect
<u>Plating Solutions, Chromium Plating: Fluosilicate Bath 95°F</u>	D-Severe Effect
<u>Plating Solutions, Copper Plating (Misc): Copper (Electroless)</u>	D-Severe Effect
<u>Plating Solutions, Iron Plating: Ferrous Chloride Bath 190°F</u>	D-Severe Effect

<u>Plating Solutions, Nickel Plating: Electroless 200°F</u>	D-Severe Effect
<u>Propylene</u>	D-Severe Effect
<u>Pyridine</u>	D-Severe Effect
<u>Resorcinal</u>	D-Severe Effect
<u>Shellac (Orange)</u>	D-Severe Effect
<u>Styrene</u>	D-Severe Effect
<u>Sulfur Chloride</u>	D-Severe Effect
<u>Sulfur Dioxide (dry)</u>	D-Severe Effect
<u>Sulfur Trioxide</u>	D-Severe Effect
<u>Sulfur Trioxide (dry)</u>	D-Severe Effect
<u>Sulfuric Acid (75-100%)</u>	D-Severe Effect
<u>Sulfuric Acid (cold concentrated)</u>	D-Severe Effect
<u>Sulfuric Acid (hot concentrated)</u>	D-Severe Effect
<u>Tetrachloroethane</u>	D-Severe Effect

<u>Tetrachloroethylene</u>	D-Severe Effect
<u>Tetrahydrofuran</u>	D-Severe Effect
<u>Toluene (Toluol)</u>	D-Severe Effect
<u>Trichloroacetic Acid</u>	D-Severe Effect
<u>Trichloroethane</u>	D-Severe Effect
<u>Trichloroethylene</u>	D-Severe Effect
<u>Turpentine</u>	D-Severe Effect
<u>Urine</u>	D-Severe Effect
<u>Varnish</u>	D-Severe Effect
<u>Vinyl Acetate</u>	D-Severe Effect
<u>Vinyl Chloride</u>	D-Severe Effect
<u>Xylene</u>	D-Severe Effect

Explanation of Footnotes

1. Satisfactory to 72°F (22° C)
2. Satisfactory to 120°F (48° C)

Ratings -- Chemical Effect

A = Excellent.

B = Good -- Minor Effect, slight corrosion or discoloration.

C = Fair -- Moderate Effect, not recommended for continuous use. Softening, loss of strength, swelling may occur.

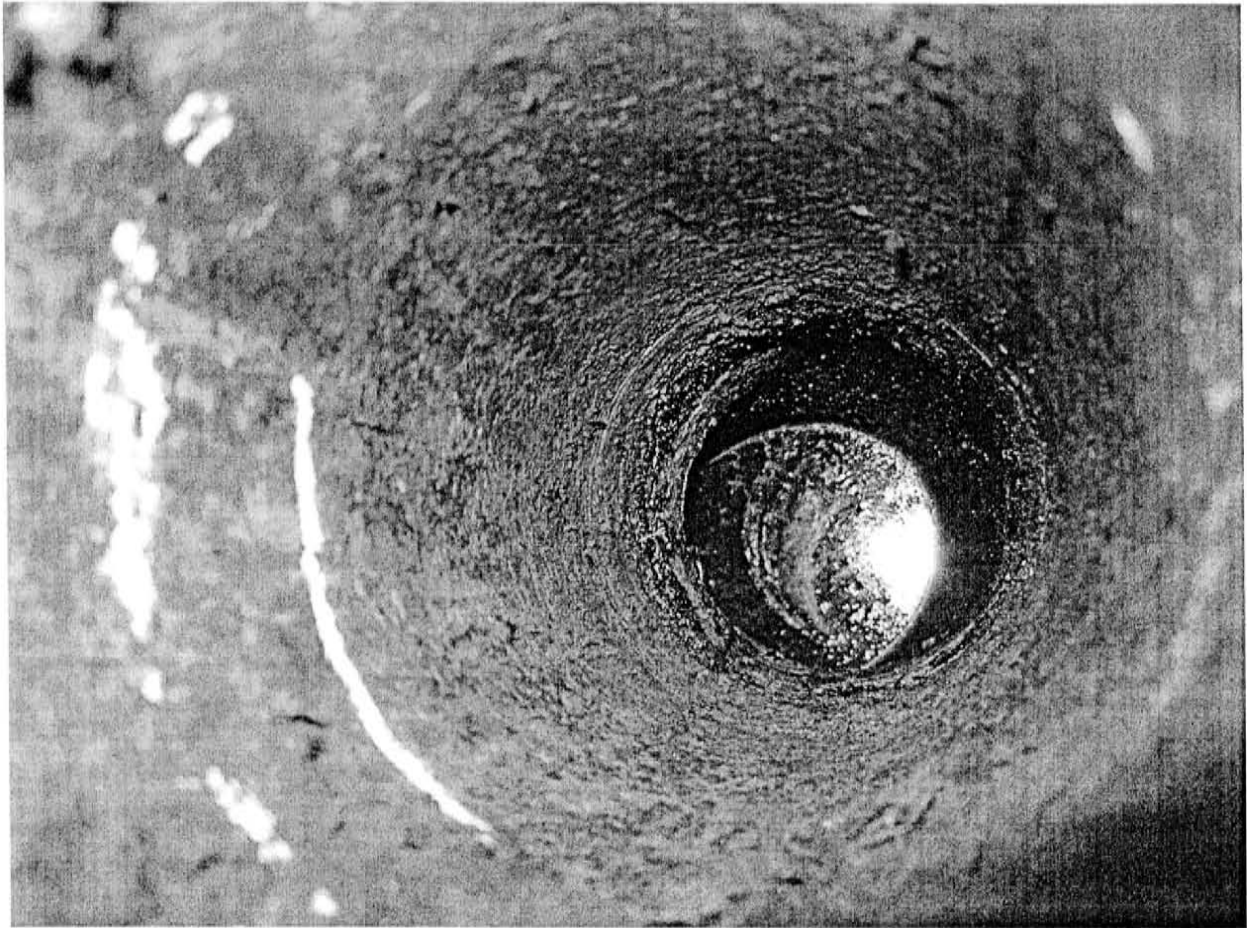
D = Severe Effect, not recommended for **ANY** use.

N/A = Information Not Available.

Appendix C Drain pictures.



Picture 1. flexiprobe P330 used to view inside piping drain system.



Picture 2. Floor drain with deformed neoprene NO-HUB connector



Picture 3. Floor drain clean-out with neoprene NO-HUB connector

Appendix D Root Cause Map

